Freshwater Mussels in the Lake Huron-Lake Erie Corridor

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An early indicator of adverse human effects on large open-water systems in North America was western Lake Erie, part of the Lake Huron-Lake Erie corridor of the Laurentian Great Lakes (Fig. 1). Local pollution of tributaries of western Lake Erie was recognized as early as 1890, when populations of whitefish (Salmonidae) and lake herring (*Coregonus artedi*) in the Detroit River declined (Beeton 1961). Waters of western Lake Erie stopped yielding whitefish and herring in the 1920's-30's, but not until the 1950's, after extensive biological investigations, were the open waters of western Lake Erie believed to have been polluted by human "local" activities (National Academy of Sciences 1970). Eutrophication (the addition of nutrients) of western Lake Erie created unsuitable conditions (primarily low dissolved oxygen concentrations) for fish and other animals in a major portion of Lake Erie—the world's 12th largest lake. By the early 1960's, Lake Erie was declared "biologically dead" (Burns 1985).

Among the many ecosystem components affected by human-induced changes to western Lake Erie (Burns 1985) is the native mussel fauna (Bivalvia: Unionidae). Reduced mussel populations that survived degraded conditions of the 1950's have been used in status and trends studies to evaluate traditional forms of pollution in western Lake Erie. Studies in the 1990's have focused on evaluating the effects of exotic species on mussel populations in the Lake Huron-Lake Erie corridor. Exotic species have recently been characterized as "biological pollution," a new concept in evaluating status and trends data. Our study shows both historical, long-term effects from human activities and recent, dramatic effects from exotic species on mussel populations in waters of the Great Lakes.

Sampling Populations

The Lake Huron-Lake Erie corridor receives water from three of the five Laurentian Great Lakes, the largest freshwater system in the world

(Fig. 1). Relatively pristine water enters the St. Clair River, passes through Lake St. Clair and the Detroit River, and enters western Lake Erie.

Freshwater native mussels were collected by scuba divers in the Lake Huron-Lake Erie corridor (Fig. 1) at 46 stations during six sampling periods from 1961 to 1992. In Lake St. Clair, mussels were collected at 29 stations in 1986, 1990, and 1992. Ten replicate quadrate samples (0.5 m^2 each [5.4 ft^2]) were obtained at each station and sampling date. In western Lake Erie, mussels were collected four times at one index station in 1989-91 and once at 17 historically sampled stations in 1961, 1982, and 1991. Sampling at the index station was performed with an epibenthic sled (46 x 25 cm [18 x 63 in]). Sampling at the 17 historically sampled stations was performed with a Ponar grab sampler. Three replicate Ponar (0.05 m^2 [0.5 ft^2]) samples of the substrate were collected at each station. Mussels were identified following Clarke (1981) and comparisons with bivalve taxonomic reference collections. Taxonomic nomenclature follows Turgeon et al. (1988) and Williams et al. (1993).

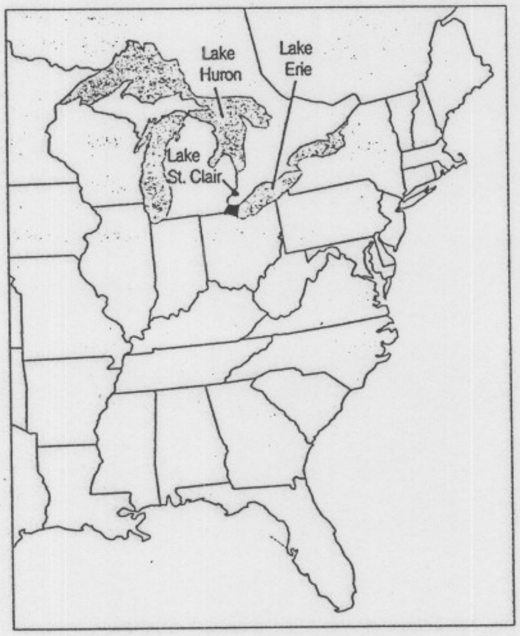


Fig. 1. The Lake Huron-Lake Erie corridor, including Lake St. Clair and western Lake Erie (in red).

Historical Status

Around 1900 the Lake Huron-Lake Erie corridor was characterized as having one of the most abundant freshwater mussel faunas in North American lakes (Goodrich and van der Schalie 1932; Mackie et al. 1980): 39 species (Table 1).

Before 1990 mussel populations existed in most areas of the Lake Huron-Lake Erie corridor (Fig. 2). In Lake St. Clair, mussel populations were similar in 1986 and 1990 (Table 2). Numbers of mussels per unit area were relatively low ($2/m^2$ [$0.2/ft^2$]), but consistent, and there were 16-18 species found throughout the lake in 1990. The relatively healthy populations of mussels are attributed to the pristine water flowing into the lake from Lake Huron (Herdendorf et al. 1986).

In western Lake Erie, mussel populations that had survived low water quality in the 1950's declined between 1961 and 1982 (Table 2). Numbers declined from $10/m^2$ ($0.9/ft^2$) to $4/m^2$ ($0.4/ft^2$), and the number of species

Table 1. Species of native mussels historically found in the Lake Huron-Lake Erie corridor of the Great Lakes (modified from Clarke and Stansbery 1988).

Species
Mucket (*Actinonaias ligamentina [carinata]*)
Elktoe (*Alasmidonta marginata*)
Slippershell mussel (*A. viridis*)
Threeridge (*Amblema plicata plicata*)
Cylindrical papershell (*Anodontoides ferussacianus*)
Purple wartyback (*Cyclonaias tuberculata*)
Spike (*Elliptio dilatata*)
Northern riffleshell (*Epioblasma torulosa rangiana*)
Snuffbox (*E. triquetra*)
Wabash pigtoe (*Fusconaia flava*)
Wavy-rayed lampmussel (*Lampsilis fasciola*)
Pocketbook (*L. ovata*)
Eastern lampmussel (*L. siliquoidea*)
White heelsplitter (*Lasmigona complanata complanata*)
Creek heelsplitter (*L. compressa*)
Fluted-shell (*L. costata*)
Fragile papershell (*Leptodea fragilis*)
Eastern pondmussel (*Ligumia nasuta*)
Black sandshell (*L. recta*)
Threehorn wartyback (*Obliquaria reflexa*)
Hickorynut (*Obovaria olivaria*)
Round hickorynut (*O. subrotunda*)
Round pigtoe (*Pleurobema coccineum*)
Ohio pigtoe (*P. cordatum*)
Pink heelsplitter (*Potamilus alatus*)
Pink papershell (*P. ohiensis*)
Kidneyshell (*Ptychobranchus fasciolaris*)
Giant floater (*Pyganodon grandis*)
Mapleleaf (*Quadrula quadrula*)
Pimpleback (*Q. pustulosa pustulosa*)
Salamander mussel (*Simpsonaias ambigua*)
Squawfoot (*Strophitus undulatus*)
Lilliput (*Toxolasma parvus*)
Fawnsfoot (*Truncilla donaciformis*)
Deertoe (*T. truncata*)
Pondhorn (*Uniomerus tetralasmus*)
Paper pondshell (*Utterbackia imbecillis*)
Rayed bean (*Villosa fabalis*)
Rainbow (*V. iris*)

Table 2. Number of species of native mussels and average (mean) density ($number/m^2$) in Lake St. Clair and western Lake Erie of the Lake Huron-Lake Erie corridor, 1961-92.

Lake/year	Total no. of species	Average (mean) no/m^2
Lake St. Clair		
1986	18	2
1990	16	2
1992	12	<1
Western Lake Erie		
1961	8	10
1982	5	4
1991	0	0

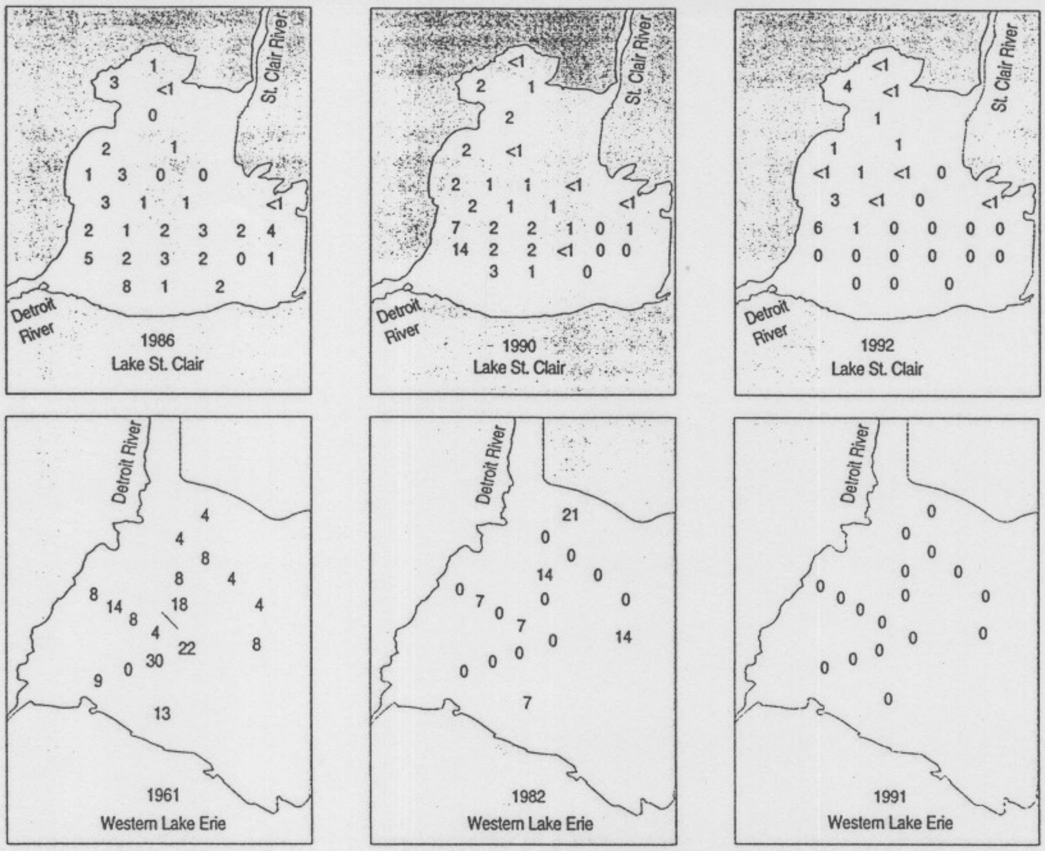


Fig. 2. Average (mean) densities (number/m^2) of native mussels in Lake St. Clair and western Lake Erie of the Lake Huron-Lake Erie corridor of the Great Lakes, 1961-92.

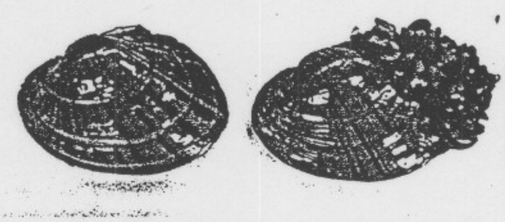
declined from eight to five between 1961 and 1982. The declining populations of native mussels are attributed to pollution that originated from tributary rivers of the lake prior to the 1970's. In the mid-1970's, pollution-abatement programs were begun, and water and substrate quality began to improve in western Lake Erie by the mid-1980's. By the late 1980's, environmental quality improved dramatically and pollution-sensitive indicators such as burrowing mayflies (*Hexagenia* spp.) began to return to western Lake Erie (Farara and Burt 1993; Schloesser, unpublished data).

Current Status

In the early 1990's, however, native mussel populations declined dramatically in the Lake Huron-Lake Erie corridor, despite improvements in water and substrate quality (Fig. 2; Table 2). In Lake St. Clair, substantial declines of mussels were documented between 1990 and 1992. Numbers and species of mussels were about half those found only 2 years earlier. Most changes in mussel populations in Lake St. Clair occurred in the southern portion of the lake, where mussels are no longer found (Fig. 2). In Lake Erie, mussel populations virtually disappeared in offshore waters between 1982 and 1991 (Fig. 2; Table 2).

Recent changes in native mussel populations in the Lake Huron-Lake Erie corridor are attributed to mortality caused by the exotic zebra mussel (*Dreissena polymorpha*); these exotics attach to the surface of mussels in such high numbers that native mussels are unlikely to be able to breathe and eat (Fig. 3). Intensive sampling indicated that native mussel populations declined rapidly between September 1989 and May-June 1990 (Fig. 4). Zebra mussels became abundant the summer of 1989, when infestation on clams increased from 24 mussels to 7,000 mussels per clam (Schloesser and Kovalak 1991; Nalepa and Schloesser 1992).

Erosion caused by deforestation, poor agricultural practices, and destruction of riparian zones, and organic and inorganic pollution have long been recognized as other causes for mussel mortality (Williams et al. 1993). Our knowledge of the zebra mussel, however, and its colonization on native mussels indicates that native mussel mortalities in the 1990's are attributable to



Courtesy D.W. Schloesser, NBS

Fig. 3. Typical native mussel (*Potamilus alatus*) uncolonized (left) and colonized (right) by the exotic zebra mussel (*Dreissena polymorpha*) in the Lake Huron-Lake Erie corridor of the Great Lakes.

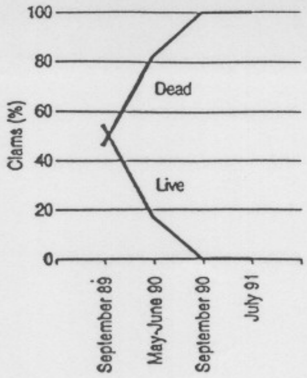


Fig. 4. Percentage of live and dead native mussels collected at an index station in western Lake Erie of the Lake Huron-Lake Erie corridor of the Great Lakes, 1989-91.

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biological pollution. Exotic species such as zebra mussels are being recognized as new and widespread threats to ecosystem stability throughout North America (Office of Technology Assessment 1993).

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